COMPARATIVE PACKAGING STUDY

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Background

Future long duration manned space flights beyond low earth orbit will require the food system to remain safe, acceptable and nutritious. Development of high barrier food packaging will enable this requirement by preventing the ingress and egress of gases and moisture. New high barrier food packaging materials have been identified through a trade study. Practical application of this packaging material within a shelf life test will allow for better determination of whether this material will allow the food system to meet given requirements after the package has undergone processing.

The reason to conduct shelf life testing, using a variety of packaging materials, stems from the need to preserve food used for mission durations of several years. Chemical reactions that take place during longer durations may decrease food quality to a point where crew physical or psychological well-being is compromised. This can result in a reduction or loss of mission success. The rate of chemical reactions, including oxidative rancidity and staling, can be controlled by limiting the reactants, reducing the amount of energy available to drive the reaction, and minimizing the amount of water available. Water not only acts as a media for microbial growth, but also as a reactant and means by which two reactants may come into contact with each other.

Objective

The objective of this study is to evaluate three packaging materials for potential use in long duration space exploration missions. One of the materials, Combitherm, is currently being used for packaging of NASA's natural form, bite size, and rehydratable foods. Due to the required 18 month shelf life for ISS missions, these foods are overwrapped with a high barrier material. Combitherm is considered the control due to the fact that it is the one currently in use. In an effort to reduce packaging mass, the ideal new material would not require an overwrap. The result would be a package of low mass and volume with reduced materials to discard.

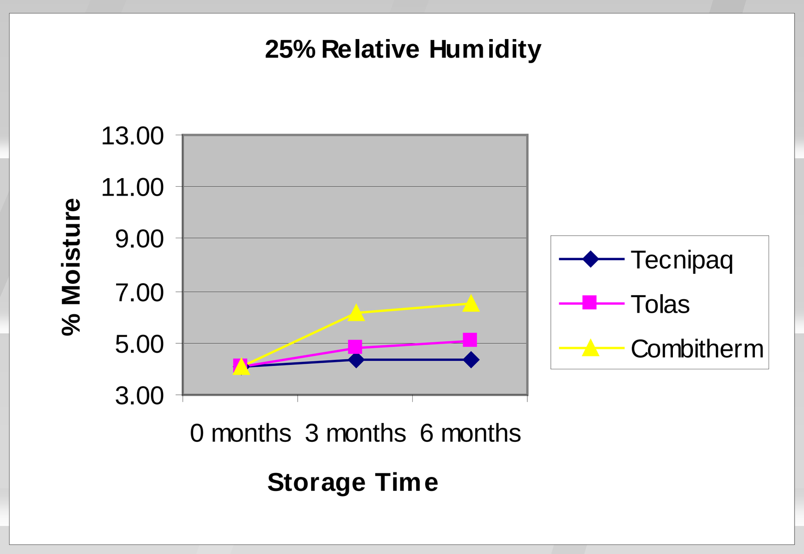
In addition, a material similar to the overwrap material currently used to extend shelf life of ISS and Shuttle foods will be tested for its utility as the sole packaging material. This material, Technipaq brand, is incorporated in this study in place of the current overwrap because it is a common off the shelf item versus the current material which is made in small quantities specifically for the space program.

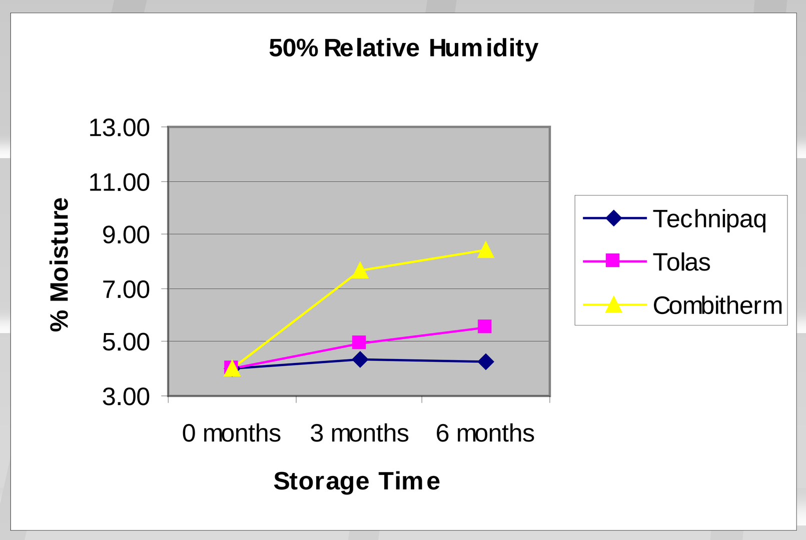
The third material is a new technology. The film is a very lightweight polyethylene terephthalate (PET) with a thin coating of aluminum oxide. It is manufactured by Tolas Health Care Packaging. The thin layer of aluminum oxide coating over the PET provides an effective barrier based on MOCON analytical results.

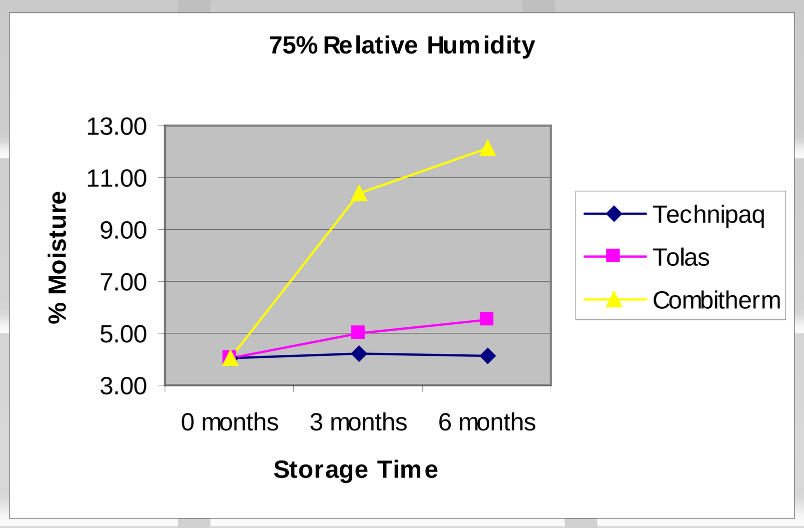
Materials and Methods

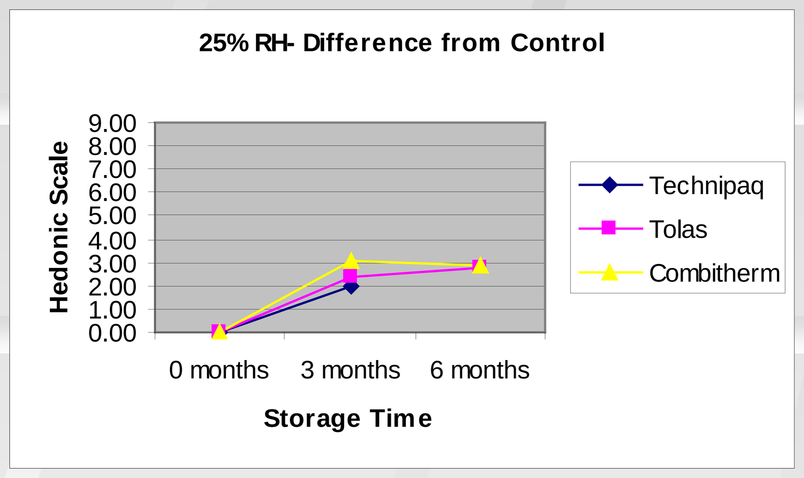
Two food products, dry cereal and peanuts, and one ingredient, cottonseed oil, susceptible to oxygen and water vapor ingress were packaged in three different packaging materials and incubated at a fixed temperature (72°F) and varying relative humidity. Storage at three relative humidities (25%, 50%, 75%) will simulate the midpoint and potential ranges of humidities on the Orion vehicle. Relative humidity is an important variable since it may impact the barrier properties of certain materials.

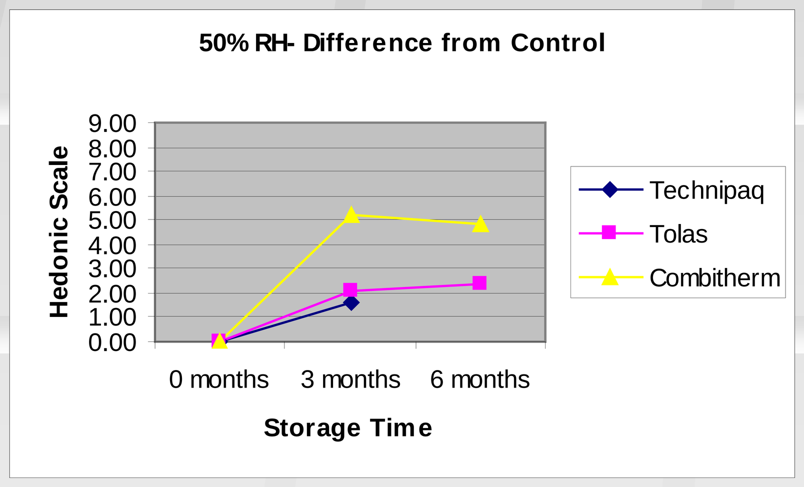
At three month intervals, sensory and quantitative analysis are being performed on the food items to measure changes due to oxygen and moisture migration through the packaging. Free fatty acid (FFA) (AOAC 41.1.21) and peroxide value (PV) (AOAC 41.1.16) are being performed on the oil for quantification of oxidative rancidity. Moisture analysis (AOAC 32.1.03) quantifies the moisture ingress of the cereal and hexanal analysis quantifies the level of rancidity in the peanut samples. Sensory methods, used only for cereal and peanuts, include Difference from Control testing which indicates when the food has changed enough for consumers to notice a difference. The data associated with the three packaging materials will be compared in order to determine which is best suited for future exploration missions.

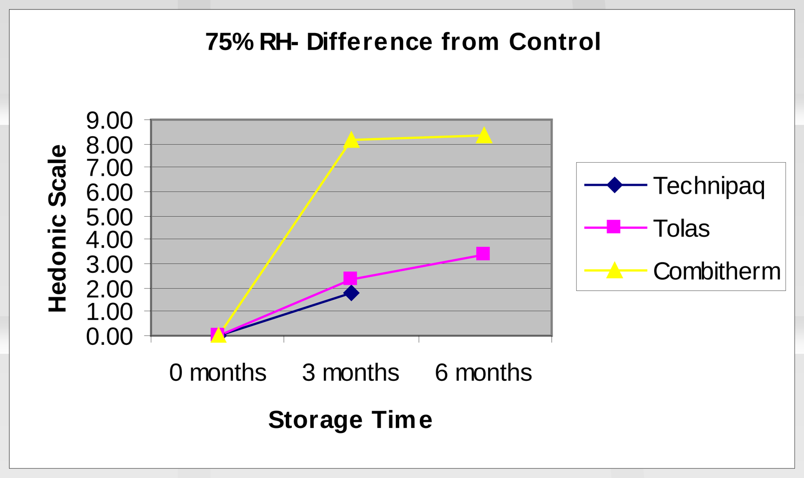












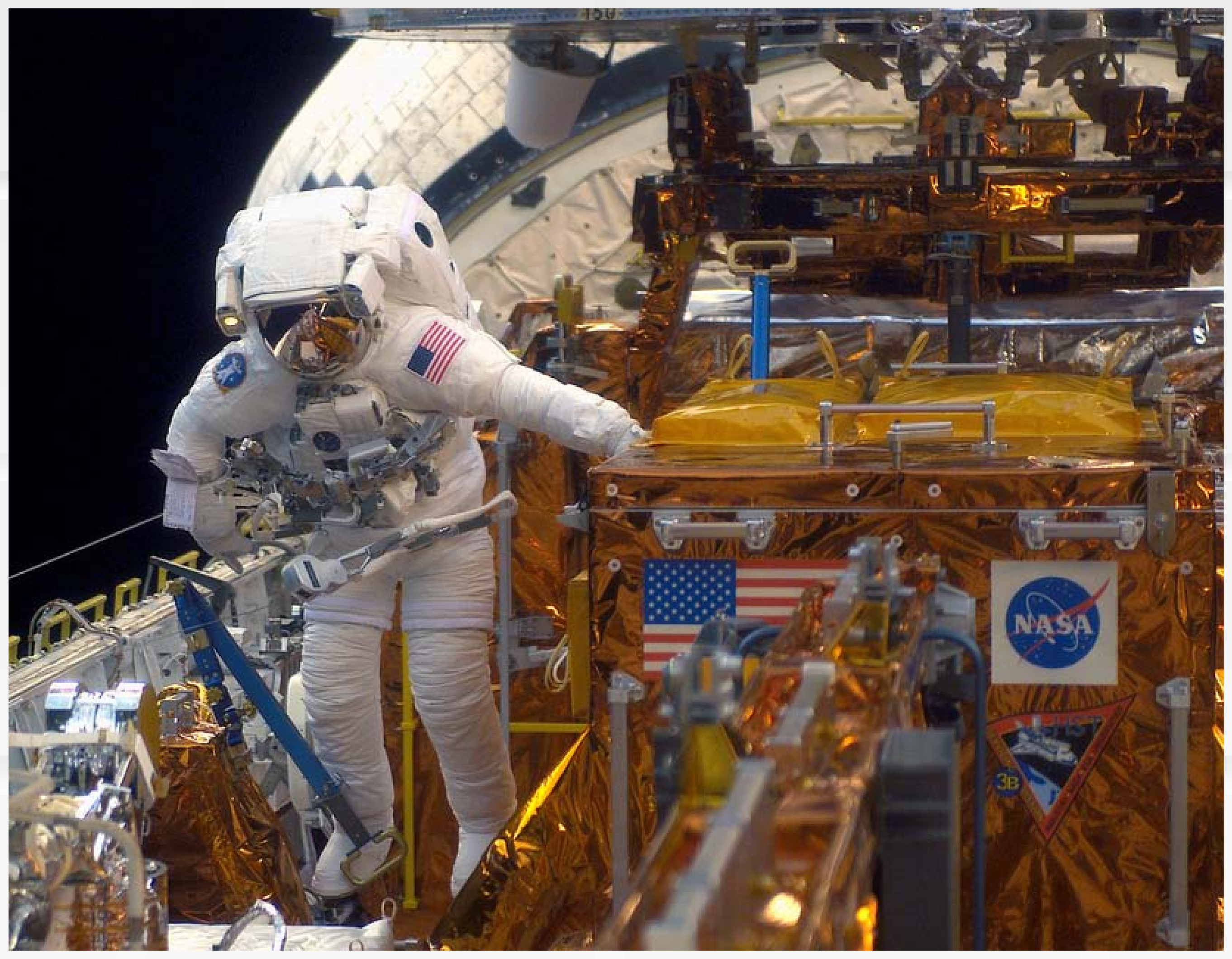
Experimental Design Matrix

	FOOD SAMPLES			
MATERIALS	**Cottonseed Oil**	**Cheerios**	**Peanuts**	
Combitherm	Cottonseed Oil/Combitherm	Cheerios/ Combitherm	Peanuts/ Combitherm	V A R I A B L E S
Technipaq	Cottonseed Oil/Technipaq	Cheerios/ Technipaq	Peanuts/ Technipaq	
Tolas	Cottonseed Oil/Tolas	Cheerios/ Tolas	Peanuts/ Tolas	
	Storage: 3 variables- *72ºF & 25%RH *72ºF & 50%RH *72ºF & 75%RH	**Storage:** 3 variables- *72ºF & 25%RH *72ºF & 50%RH *72ºF & 75%RH	**Storage:** 3 variables- *72ºF & 25%RH *72ºF & 50%RH *72ºF & 75%RH	
	Analyses: *Free Fatty Acid *Peroxide Value	**Analyses:** *Moisture *Sensory	**Analyses:** *Hexanal *Sensory	

Rate of Analysis = Full testing once every 3 months for 18 months, then quantitative analyses only through 36 months.

Results and Discussion

- Most apparent changes were seen with the Cheerios, which are highly susceptible to moisture absorption.
- The sensory and analytical data are in agreement.
- Since sensory testing all of the samples would have been too much for one sensory panel, samples that showed no difference from control during analytical testing were excluded from sensory testing
- The Cheerios stored at 75% were very soggy
- The results confirm that the current primary package (Combitherm) is insufficient and therefore does require a secondary overwrap to provide the required 18 month shelf life.
- The new Tolas material is not performing as well as the overwrap (Technipaq) material, but is doing well and may prove to be sufficient in providing the required 18 month shelf life, while reducing the packaging to a single pouch
- Final conclusions will be made once the 18 month study is completed in Sept 2009



Conclusion

The results of the peanuts and cottonseed oil were not presented because to date, there have been no drastic changes found in the analytical results. Sensory evaluation for peanuts packaged in Combitherm and stored at 75%RH showed similar results to Cheerios, but no other noticeable changes were observed. Currently, the biggest factor effecting the samples is moisture, but rancidity, caused by oxygen ingress may become more apparent in the next 12 months of testing.

References

Horwitz and Latimer. *Official Methods of Analysyis of AOAC International, 18th Edition, 2005*. AOAC International, co. 2005.

Meilgard, Vance Civille, Thomas Carr. *Sensory Evaluation Techniques*. CRC Press, 1988.